Patent Application of

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for

BICYCLE CRANK AXLE BEARING ASSEMBLY

TECHNICAL FIELD

The present invention relates to the field of bicycles, more particularly to a bottom bracket assembly for a bicycle.

BACKGROUND OF THE INVENTION

Typical human powered bicycles are propelled by pedals mounted on cranks at opposite ends of an axle. The cranks drive the axle, on which usually one or more sprockets are mounted that engage a chain to transfer the rotary motion to a rear wheel. The part of the bicycle frame where the axle is mounted is called the bottom bracket. Here, the axle is rotatably held in a bearing, so that it can rotate with very low friction.

For mounting the axle with low friction, ball bearings are employed, consisting of inner and outer races with interposed bearing balls. In many known bottom bracket assemblies, the inner race is formed as a part of the axle or spindle. However, this has proven to create

a number of problems. Bearing races must be very hard, and hence brittle, due to high contact stresses present in rolling element ball bearings. Brittleness, however, is highly undesired for the spindle because it reduces the ability of the spindle to absorb high impact energies occurring in some situations.

One example of a bottom bracket bearing assembly where the inner races of ball bearings are formed by the spindle itself is described in French patent 270,698 to Bazille.

Other known bottom bracket bearings of the prior art make use of sealed cartridge bearings, which integrate the two races with the bearing and are available as readily assembled units. Cartridge bearings can easily be replaced when worn or damaged. The successful use of cartridge bearings in bicycle bottom brackets, however, requires the designer to ensure that the inner and outer bearing races are correctly aligned. If axial loads lead to misalignment of the bearing races during assembly or use of the bottom bracket, damage is likely to occur.

If the both the inner and outer bearing races of a cartridge bearing are fixed axially in the bottom bracket assembly, correct alignment can only be ensured by very tight control of manufacturing dimensions and tolerances. The distance between the fixed positions of the two outer bearing races must be nearly identical to the distance between the inner bearing races. This has proven to raise manufacturing cost and make the overall bottom bracket design intolerant to manufacturing and assembly variations.

A number of known bottom bracket assemblies of the prior art solve the problem of correct alignment of the inner and outer bearing races by allowing the inner races to float on the spindle while the outer races are fixed in an outer bracket portion, typically being clamped between a shell and adapters inserted at both ends. However, this design makes it difficult to efficiently incorporate crank stops into the bottom bracket. Crank stops are a desirable addition to a bottom bracket because they ensure correct and consistent axial alignment of the installed crank arms.

U.S. patent 3,903,754 to Morroni and U.S. patent 4,093,325 to Troccaz both show bottom bracket assemblies where a spindle is rotatably mounted in the bottom bracket by cartridge bearings. The inner races of the cartridge bearings are spaced apart by shoulders on the spindle while the outer races are spaced apart by a tubular spacer or shell. Axial alignment of the inner and outer bearing races in this case can only be accomplished by matching the width of the shoulders and the tubular spacer, using very tight dimensional tolerances.

U.S. patent 4,545,691 to Kastan shows a bottom bracket assembly for a bicycle where the inner races of the cartridge bearings are fit on the axle and are clamped between a shell and an adapter to fix their axial position. The outer races are butted against shoulders located in the bearing adapters. During initial assembly, the bearing adapters are allowed to float. The adapters are then tightened into axial alignment with the inner bearing races by a tapered split ring.

The present invention aims to provide a bottom bracket assembly for a bicycle, where in a simple construction cartridge bearings can be used advantageously.

SUMMARY OF THE INVENTION

According to the invention, there is provided a bottom bracket assembly for a bicycle that uses cartridge bearings. Inner races of the cartridge bearings are fit on the spindle and are fixed in both axial directions by abutting stop elements.

According to a first aspect of the invention, the outer races of the cartridge bearings are mounted such that they are free to move in both axial directions. This eliminates the need for very tight control of manufacturing dimensions and tolerances.

Providing the outer bearing races with adjacent gaps in both axial directions allows for these races to be shifted small distances during installation or under high load during use. The inventor has recognized that the inner bearing races are less likely to be damaged by high axial loads since the spindle provides good support for these races, especially if they are press-fit thereon. The outer bearing races, however, even if they are press-fit into the outer bracket portion, known as the adapters, are more likely to be damaged. The adapters are usually thin-walled and are often manufactured from lightweight materials. Consequently they do not provide as much support as the stiffer spindle. Allowing the outer races to float by a small amount axially when subjected to high loads, such as encountered in a crash situation, effectively helps to protect these bearing races from damage.

According to a second aspect of the invention, the inner races of the cartridge bearings are fit on the spindle and are clamped between abutting inner and outer stop elements. The ends of the spindle comprise adapting portions to receive crank arms. The stop elements fixing the inner races of the cartridge bearings on the spindle also serve as stop elements for the axial location of the crank arms.

Crank arm stop elements, henceforth known as crank stops, are useful because they provide consistent axial location of the crank arms when they are installed on the spindle. In prior art bottom brackets that allow the inner bearing races to float on the spindle to achieve correctly aligned races, crank stops could only be provided by steps included in the spindle. These steps increase machining complexity and lead to a reduction in bearing strength because the bearing must fit over the step. Consequently the inner bearing races must be a larger diameter than otherwise would be necessary. For a fixed outer bearing race diameter, using larger inner bearing races results in smaller bearing balls, thus reducing the overall load carrying capability and life of the bearing. Thus, according to the second aspect of the invention, there is provided a very simple construction to effectively utilize cartridge bearings of sufficient strength and provide crank stops without increased machining complexity.

Numerous other benefits and advantages will become apparent from the following detailed description of a preferred embodiment of the invention with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a side view of a bicycle.

Fig. 2 shows a partial longitudinal cross-sectional view of a first embodiment of a bottom bracket of the bicycle from Fig. 1.

Fig. 2A is an enlarged fragmentary detail of the area labeled 2A in Fig. 2.

Fig. 2B is an enlarged fragmentary detail of the area labeled 2B in Fig. 2.

Fig. 2C is an enlarged fragmentary detail of the area labeled 2C in Fig. 2A.

Fig. 3 is a partial longitudinal cross-sectional view of the bottom bracket assembly of Fig. 2 with installed crank arms.

Fig. 3A is an enlarged fragmentary detail of the area labeled 3A in Fig. 3.

Fig. 4 is a partial longitudinal cross-sectional view of a second embodiment of a bottom bracket assembly.

Fig. 4A is an enlarged fragmentary detail of the area labeled 4A in Fig. 4.

Fig. 4B is an enlarged fragmentary detail of the area labeled 4B in Fig. 4.

Fig. 5 is a partial longitudinal cross-sectional view of third embodiment of a bottom bracket assembly.

Fig. 5A is an enlarged fragmentary detail of the area labeled 5A in Fig. 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 generally shows a bicycle **10** with a bicycle frame **12**, on which are mounted crank arms **14**, **16** with pedals **18**. Crank arms **14**, **16** are connected to an axle **20**, which is rotatably held in frame **12**.

Fig. 2 shows an axial or longitudinal cross section of the area where the axle, or spindle **20**, is received in the bicycle frame **12**.

On top of Fig. 2 there is shown a tube forming part of the bicycle frame **12**, attached to a tubular sleeve **22** containing a first embodiment of a bottom bracket assembly generally indicated as **24**.

This first embodiment of a bottom bracket assembly according to the present invention includes the spindle **20**, preferably of steel, which has adapting portions **26** on both axial ends to receive crank arms. The adapting portions **26** comprise an outer portion adapted to be received in the hub portion **54** of the cranks **14**, **16** and an inner thread **28** for fixing the cranks to the spindle.

The spindle **20** is mounted in the bottom bracket by means of two cartridge bearings **30**, **32** arranged near the ends of the bottom bracket assembly **24**. Cartridge bearings **30**, **32** are sealed cartridge bearings, available as readily assembled units. As can be seen in Fig. 2A, which is an enlarged view of the area 2A of Fig. 2, each cartridge bearing **30**, **32** comprises inner and outer bearing races **34**, **36** with bearing balls **38** there between.

The bottom bracket assembly **24** arranged in sleeve **22** comprises an outer bracket portion **40**, consisting of a cartridge shell **42** and two adapter cups **44**.

The inner bearing races **34** of cartridge bearings **30**, **32** are press-fit over the spindle **20**. Adapter cups **44** are fit onto the outer races **36** of cartridge bearing **30**, **32**, such that the outer races **36** are held in the outer bracket portion **40**.

Spindle **20** has enlarged annular steps **46** arranged at a distance from its opposite ends. The inner bearing races **34** of cartridge bearings **30**, **32** are fit on the spindle **20** and axially abut against steps **46**.

Further fit on the spindle are stop rings **48** acting as crank stop elements. The crank stops **48** are press-fit over the spindle **20** and clamp the inner bearing races **34** between the crank stops **48** and the spindle steps **46**. The inner bearing races **34** are thus axially fixed.

On the other hand, the outer bearing races **36**, which are received in the adapter cups **44**, are free to float a small amount axially between a shoulder acting as bearing stop **50** of the adapter cups **44** and the axial ends **52** of the shell **42**. As can be seen in Fig. 2A, 2B and 2C, gaps **54** are provided to both axial sides of the floating outer bearing races **36**. Gaps **54** may be of unequal size for each bearing. In the embodiment shown the outer race **36** of cartridge bearing **30** to the left in Fig. 2 has only very small gaps of 0.05 mm length, which are only visible in the enlarged view of Fig. **2C**. The outer race **36** of cartridge bearing **32** to the right in Fig. 2 has gaps of roughly 0.5 mm, which allow the outer race **36**, to axially move by the corresponding distance.

This bottom bracket assembly with axially fixed inner races **34** and floating outer races **36**

eliminates the need for very tight dimensional tolerances. In prior constructions of this type, the length of sleeve **42** would have to match exactly the distance between spindle steps **46**. According to the present invention, sleeve **42** is deliberately made shorter than that distance.

During installation, the outer bearing race **36** will axially move to a position where the inner and outer races of bearings **30**, **32** are aligned. Also, if during use high axial loads occur, outer bearing races **36** can axially shift by a small amount to counter said loads, such as encountered in a crash situation. In case of excessive axial forces, one of the outer bearing races **36** will butt against either the bearing-stop **50** in the adapter **44** or the respective end **52** of the shell **42**. Sufficiently close tolerances can be easily held in manufacturing to keep this axial movement under an amount noticeable by the bicycle rider. The present invention thus produces a bottom bracket assembly with correctly aligned inner and outer bearing races that is highly tolerant of variations in both the manufacturing process of the bottom bracket assembly itself and installation of the bottom bracket assembly into a bicycle frame **12**.

As shown in Fig. 2, the bottom bracket assembly is installed in tube **22** of a typical bicycle frame **12** by outer threads provided on the adapter cups **44**.

Fig. 3 shows the bottom bracket assembly **24** with installed cranks **14, 16**. Cranks **14, 16** each include a hub portion **54** with a central hole, which receives the adapting portions **26** at the ends of spindle **20**. Adapting portions **26** in this first embodiment comprise a star-

like outer cross-sectional shape with longitudinal splines at the ends of spindle **20**. These splines are received in a correspondingly shaped hole of hubs **54**, such that cranks **14, 16** are rotatably fixed onto spindle **20**.

As can be seen in Fig. 3 and the enlarged view of Fig. 3A, hub portion **54** axially abuts against crank stop **48**, thus ensuring consistent axial location of the crank arms when they are installed on the spindle **20**. This is especially important with regard to crank arm **14** to the right in Fig. 3, which is shown to carry a number of sprockets **56**. The defined axial location of these sprockets is important for optimum chain shifting operation.

As can be seen again in the enlarged view of Fig. 3A, the elements are provided on spindle **20**, in the following order, from the inside to the outside: spindle step **46**, inner race **34** of cartridge bearing **32**, crank stop **48**, crank hub **54**.

Fig. 4 shows a second embodiment of a bottom bracket assembly **60**. This second embodiment of a bottom bracket assembly closely resembles the first embodiment of Fig. 2, 2A, 2B, 2C, 3, and 3A. The same reference numerals are used for corresponding elements. Bottom bracket assembly **60** will consequently not be described in detail, but reference will only be made to elements different from the first embodiment.

In the second embodiment, spindle **20** is solid and not hollow as the spindle of first embodiment. Also, adapting portions **26** for mounting crank arms are shaped differently. Instead of spline shaped adapting portions in the first embodiment, here adapting portions

26 of the spindle have a square cross-section. These adapting portions **26** can be received in correspondingly shaped hub portions of crank arms (not shown) in the same way as the spline shaped adapting portions shown in Fig. 3.

As in the first embodiment, cartridge bearings **30**, **32** are provided. The inner races **34** of cartridge bearings **30**, **32** are clamped between steps **46** on the spindle **20** and crank stops **48**, such that they are axially fixed. Of the outer bearing races **36**, the outer bearing race of cartridge bearing **30** to the left in Fig. 4, shown in detail in Fig. 4A is also axially fixed. As shown in the enlarged view of Fig. 4A the end of shell **42** and bearing stop **50** of adapter cup **44** axially abut against the interposed outer race **36** of cartridge bearing **30**.

On the other hand, outer race **36** of cartridge bearing **32** to the right in Fig. 4 has gaps **54** provided at both axial ends thereof, such that it can move axially by a small amount.

It has been found that the above construction with only one outer race being allowed to float is enough to correctly align the bearing races and eliminate the need for tight dimensional tolerances.

Fig. 5 shows a third embodiment of a bottom bracket assembly **70**. Again, the construction resembles first and second embodiments. The same reference numerals are used for corresponding elements. The third embodiment will not be explained in detail, but reference will be made only to the differences to the first and second embodiments.

As can be seen in Fig. 5, spindle **20** is mounted with cartridge bearings **30**, **32** in outer bracket portion **40**. In the third embodiment the outer bracket portion **40** only comprises one adapter cup **44**. The other adapter cup is integrated with the cartridge shell to form a single component **72**. As can be seen in the enlarged view of Fig. 5A, this configuration produces a bottom bracket assembly in which the outer race **36** of the right end bearing **32** can float axially. Combination element **72** has a bearing stop **50** to limit axial movement of the inner bearing race **36** to one side. On the other axial side of the outer bearing race **36**, the outer bracket portion is open.

Although the invention has been explained in relation to its preferred embodiments, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.